Project Report: Hematite on Mars: Implications for Astrobiology

Lead Team:	***Johnson Space Center***
Project Title:	***Hematite on Mars: Implications for Astrobiology***
Project Investigator:	***Carlton Allen***

Project Progress

Our approach consists of three parts: First, we are evaluating literature data on the occurrence of low temperature, aqueous deposited hematite. Such deposits include some banded iron formations (BIFs), as desert varnish and other iron−rich deposits in the geologic record. Next, we are undertaking a laboratory study of samples containing iron oxides to document the hematite occurrences, the chemistry of the rock and its oxides, and the presence or absence of morphologic biomarkers such as fossil microbes, filaments, or biofilm. Finally, we are applying the results to an evaluation of hematite sites on Mars as identified by the Mars Global Surveyor (MGS).

This project is also related to our Rock Varnish project, which is identifying iron and manganese oxides and hydroxides associated with alteration zones or coatings on rocks.

Highlights

- Iron oxides including hematite are usually associated with microfossils preserved biosignatures in desert varnish, ancient banded iron formations, and fossilized biofilms.
- Based on terrestrial examples, the Martian hematite sites identified by the Thermal Emission Spectrometer (TES) on MGS may be excellent candidate sites for a search for life.
- The presence of hematite on Mars as documented by the Mars Surveyor and by studies of Martian meteorites shows that a significant oxidation gradient has existed on Mars between the surface and subsurface. Based on terrestrial examples, this gradient may have provided energy to microbes on Mars and can substitute for light energy to keep microbial colonies alive and thriving in the Martian subsurface.

Roadmap Objectives

- ***Objective No. 5:*** Linking Planetary Biological Evolution
- ***Objective No. 6:*** Microbial Ecology
- ***Objective No. 8:*** Past Present Life on Mars
- ***Objective No. 17:*** Planetary Protection

Mission Involvement

*Mission Class**	*Mission Name (for class 1 or 2) OR Concept (for class 3)*	*Type of Involvement***
1	MER 2003 rovers	Science advice on Hematite
3	Scout	Participation on science teams
2	2009 Smart Lander	Participation on science teams

* Mission Class: Select 1 of 3 Mission Class types below to classify your project:
1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long−lead future mission / societal issues (e.g., far−future Mars or Europa, biomarkers, life definition)

** Type of Involvement = Role / Relationship with Mission
Specify one (or more) of the following: PI, Co−I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).

Understanding the occurrence of hematite in various terrestrial sediments and low temperature deposits will provide the basis for targeting Mars robotic missions to hematite sites already identified by TES. The 2003 Mars Exploration Rover (MER) Landers are excellent examples of missions that may be targeted to one or more hematite sites. As we understand the morphology, chemistry, and key characteristics of terrestrial hematite occurrences associated with biogenic activity, we will be more intelligently able to design instruments, procedures, and operations that can be aimed at detecting evidence for past life on Mars. Consequently, the work of this project will feed directly into Mars mission site selection and operational planning for 2003. In addition, depending on the 2003 results, site selection, analysis instrument selection, and operation planning for the 2009 lander may be influenced by the results of this project. Similarly, the next decade sample return mission may be directed at a site containing iron oxides with the expectation that biosignatures may be preserved in such deposits.

Field Expeditions

Field Trip Name: Southwest Desert Varnish Collecting	
Start Date: 12/22/2001	***End Date:*** 01/08/2002
Continent: North America	***Country:*** USA
State/Province: TX, AZ, NV	***Nearest City/Town:*** Van Horn (TX), Winslow (AZ), Henderson, NV
Latitude:	***Longitude:***
Name of site(cave, mine, e.g.):	***Keywords:*** desert varnish
Description of Work: Collected at various sites throughout the SW of USA for desert varnish. Collection includes from upper Sonoran and eastern Mojave deserts.	
Members Involved: Teresa Longazo	

Cross Team Collaborations

Rachel Schelble completed her undergraduate degree in the Earth and Space Sciences Dept. at the University of New Mexico. She will start graduate work in the Fall of 2002 at the University of Southern California (USC). She will be studying the preservation of microfossils by iron oxidation with Dr. Kenneth Nealson of the USC/Jet Propulsion Laboratory (JPL) Team.